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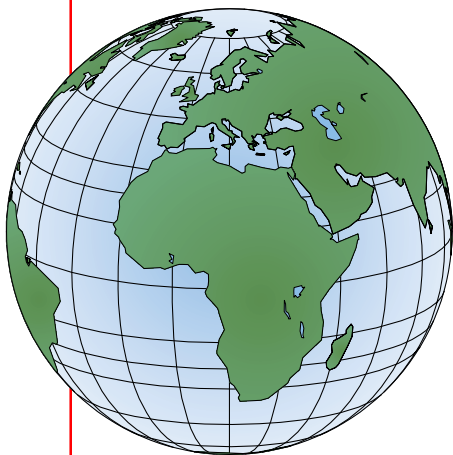
### About the Cover:

Family vehicles in the U.S. consume enough fuel each year to cover a regulation-size football field to a depth of about 40 miles. FETC partners with industry and other organizations to develop and deploy ultra-clean, high-performance fuels, ensuring that we can continue to depend on our transportation-based economy to bolster our transportation-based lifestyle.



Arthur L. Baldwin  
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# No Regrets Kutlwanong



In South Africa, as families prepare morning and evening meals, thousands of inefficient stoves in each township spew thick smoke, resulting in ambient levels of sulfur oxides, nitrogen oxides, and fine particulates that are 4 to 10 times higher than standards set by the World Health Organization.

**I**n rural townships in the Republic of South Africa (RSA), women and children spend 4 to 8 hours each day gathering wood and other biomass materials to fuel inefficient, high-polluting stoves for cooking and heating. The stoves are fired up in uninsulated substandard houses. In urban townships, residents purchase coal, biomass, and paraffin (a liquid fuel, like kerosene)—again for inefficient, high-polluting stoves used in substandard houses that lack proper ventilation—at costs that eat up 40 percent or more of their small incomes.

Because stove pollution occurs close to the ground, frequent temperature inversions (created by the weather) do not allow the gases to escape above about 300 meters. Not unexpectedly, millions of families suffer from upper respiratory diseases and carbon monoxide poisoning as a direct result of the high-polluting stoves, resulting in illness and death.

These stoves also cause other serious problems—chronic “burning eye” sensations and headaches from paraffin fumes—as well as fires that periodically destroy dozens of houses and cause even more deaths. Because poverty often dictates fuel purchases in small quantities, paraffin is frequently dispensed in 750-milliliter bottles, which leads to tragic poisoning deaths from accidental ingestion by small children who mistake the contents for beverages.

Long-term poverty, chronically ill residents, smoke-filled houses, and polluted skies have led to a number of RSA initiatives to deal with those problems.

*FETC researcher Mark Freeman demonstrates hand-held carbon-monoxide monitors to residents of Kutlwanong, a rural township in north-central South Africa near the city of Kimberley. Kutlwanong is also a South African word meaning “let us understand each other.”*



## FETC Helps the RSA Find Solutions

In 1994, South Africa's free election ended decades of apartheid and ushered in a new era of democracy under President Nelson Mandela. A national Reconstruction and Development Program was established to rebuild communities and address education, training, jobs, living conditions, and social issues. Included was a massive electrification and housing program for about 2.5 million families over a 5-year period. Prior to this program, less than 45 percent of RSA homes had access to electricity, and over 60 percent of the RSA population breathed air that wasn't safe according to World Health Organization standards.

In 1995, the US/RSA Gore/Mbeki Binational Commission was established to facilitate activities between the two governments to support sound policy making and encourage

private-sector participation. As a result of DOE's involvement, the Commission established a Sustainable Energy Committee to lead several key initiatives, including an Integrated Household Energy Delivery Pilot Project and a Low-Smoke Fuels Project. Because of our extensive history in combustion research and related environmental issues, the Commission asked FETC to lend our support to these two projects.

From the outset, FETC has worked with U.S. businesses, the U.S. Agency for International Development, and the RSA Department of Minerals and Energy (DME). Workshops hosted by FETC in Pittsburgh as well as by DME in Pretoria during 1996 brought together over 60 U.S. and South African organizations to discuss problems associated with the high-polluting, inefficient stoves and the need for improved stoves, low-smoke fuels, energy-efficient

housing, and improved power generation and distribution.

DOE subsequently signed a Memorandum of Understanding (MOU), with the community leaders of Kutlwanong, PEER Africa (a subsidiary of a U.S. civil engineering firm, PEER Consultants PC, that is pursuing infrastructure development projects in South Africa), the Northern Cape Provincial Housing Department, and DME to pursue the possibility of building energy-efficient housing. Out of the MOU came the first energy-efficient demonstration house, called an ECO™ house, dedicated in March 1996.

PEER Africa involved the Kutlwanong community in all aspects of the conception, design, social acceptability, and construction of the first ECO™ house. Two hundred ECO™ houses were completed in 1998. A final phase is now under way to build 2,300 more ECO™ houses. With assistance from PEER and community leaders, residents fill out applications to receive subsidized housing; the maximum subsidy equates to about \$3,000 for the poorest families.





ECO™ houses are about 30 percent larger and considerably more attractive than other houses (typically all brick) of the same price. PEER's passive-solar-designed brick homes provide comfortable living spaces that dramatically reduce the need for space heating, allowing residents to lower their use of high-polluting stoves and helping them reduce their household heating bills by 60 to 80 percent. These cost savings help break the cycle of poverty, reduce stove pollution and CO<sub>2</sub> emissions, and make other options more affordable to residents, such as electricity and better quality stoves.

What is most notable about the Kutlwanong housing project is that it was one of only 13 *No Regrets* case studies presented at the United Nations Conference on Global Climate Change held in December 1997 in Kyoto, Japan. *No Regrets* projects are those with low risk and common sense social, financial, and policy benefits. In July 1998, PEER and the International Institute for Energy Conservation received approval from the U.S. Initiative on Joint Implementation for a 6,000 ECO™ house project in Guguletu Township near Cape Town.

This U.S. initiative is officially recognized under the U.N. Framework on Climate Change and is designed to allow U.S. organizations, such as utilities, to participate through investments and emissions trades in approved projects that can achieve lower-cost greenhouse gas reductions in foreign countries.

These RSA low-smoke fuels and housing projects are consistent with FETC's current focus on global climate change, particularly those encouraging opportunities to reduce greenhouse gas emissions from fossil fuel combustion.

### Future and Long-Term Benefits

The US/RSA energy-efficient housing activities led by PEER have successfully involved township residents in leadership roles. Residents have acquired skills related to housing design and construction as well as business and community development. These accomplishments have energized hope and opened the door to new possibilities. For example, the Kutlwanong and Guguletu communities could serve as incubators for the evaluation and demonstration of other U.S. products and technologies, such as solar power and distributed power generation.

According to FETC researcher Mark Freeman, who worked with residents in Qalabotjha and Kutlwanong townships, the effort has produced fast results. "Although once timid and stymied by an oppressive political and economic environment for generations under apartheid, in just a few years with PEER's

program, community leaders have emerged to inform other residents and townships about the need for energy efficiency and new technology," says Freeman. Now these leaders make presentations to RSA government officials. Community interactions ensure that technical solutions fit the needs of the people and become socially acceptable. The resulting skills transfer—sometimes called capacity building—has allowed residents to help solve not just their own problems, but those of their neighbors. Freeman describes PEER's community-based approach as a key reason for the growing success of the ECO™ housing developments that have become a showcase in South Africa.

DOE views South Africa's housing and low-smoke fuel projects as opportunities for U.S. firms to participate in developing South Africa's infrastructure. U.S. companies can earn greenhouse gas emissions credits to offset their emissions at home, and possibly gain marketing inroads into South Africa's energy and power sector.



As a result of electrification goals, ESKOM—the RSA’s largest utility—is actively considering more efficient re-powering options to meet the increased capacity demand associated with new electrical connections. A new project with ESKOM has been funded by the U.S. Trade and Development Agency that involves FETC and U.S. industry. The project is a commercial feasibility study for fluidized-bed combustion re-powering to introduce clean-burning, efficient U.S. power generation technology to South Africa.

Clearly, making energy-efficient housing more available will help eliminate inefficient, high-polluting stoves and will provide residents with greater access to electricity as well as other goods and services. By making energy more affordable, the transition to clean power can be accelerated along with overall economic growth.

In the future, South Africa hopes to expand the use of so-called low-smoke fuel, a processed fuel of coal or biomass treated to

reduce smoke and particulate emissions. DME has launched a program targeted at developing standards and policies for low-smoke fuels. FETC provided technical assistance to DME in designing the program. Initial results showed that overall, pollutants were reduced by 50 percent or more.

With funding from USAID Pretoria and using emissions monitoring equipment donated by U.S. firms, Freeman conducted 138 household surveys in Qalabotjha and Kutlwanong (with PEER). The surveys identified dangerously high levels of indoor carbon monoxide from the use of high-polluting stoves. Some houses were found to have carbon monoxide levels in bedrooms that were over twice the levels in kitchens because of poor ventilation and high-polluting stoves. In describing the survey effort, Freeman said, “We demonstrated life-saving techniques to the residents. We discussed maintenance and better operation of stoves. We showed that simple intervention, such as

educating residents about carbon monoxide and opening windows, could work.”

Soon after the survey results began to be publicized, PEER helped catalyze efforts that led to an indoor air quality workshop sponsored by USAID Pretoria and IIEC-Pretoria to identify a plan of action. PEER is now setting up a pilot program to provide Kutlwanong community leaders with monitoring equipment. The leaders will literally go door-to-door to advise residents, red-tag hazardous stoves, introduce a stove replacement program, and suggest simple intervention measures.

As the world debates greenhouse gases and other global issues in the next century, the recent developments in South Africa demonstrate the positive results that come from government-private industry and international partnerships. By initiating interrelated programs in new fuels, housing, and electrification, the RSA has laid out a practical roadmap that can lead toward improving the standard of living and public health of its citizens while helping to secure the promise of a new democracy.



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